



# OPTICAL METROLOGY AND CALIBRATION OFFERS

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# IMMERVISION'S OPTICAL METROLOGY AND CALIBRATION OFFERS

address the needs of optical, system, and production engineers working with all forms of wide-angle lens assemblies and camera systems.





## Camera are Ubiquitous

Cameras are now ubiquitous in consumer, commercial, industrial, and military applications.

Optical metrology involves measuring the parameters associated with camera lens assemblies (modules) and sensors. If you cannot accurately measure the parameters associated with a lens you cannot replicate it or mass-produce it. Meanwhile, optical calibration is the activity of checking, by comparison with a standard, the accuracy of a camera system. It may also include adjustment of the system to bring it into alignment with the standard.

## Unlimited Degrees of Freedom

The lens assemblies in modern cameras are composed of stacks of sub-lenses that correct for things like chromatic aberration.

To provide optimal sensor coverage, asymmetric pixel density, and more “usable” pixels containing better data, state-of-the-art lens assemblies employ freeform technologies that support unlimited degrees of freedom.

Unfortunately, although the camera industry has developed robust toolsets about the metrology and calibration of optical systems based on rotationally invariant aspheric lenses, corresponding technologies for use with freeform lenses are relatively immature.

# Our Solution

Immervision has developed a suite of hardware and software optical metrology and calibration tools that are applicable to camera systems employing any variation of rotationally invariant aspheric to fully freeform implementations of standard, wide-angle, super-wide angle, ultra-wide-angle, and fisheye lenses.

Based on these tools, we offer a variety of optical metrology and calibration services ranging from benchmarking the parameters of a single lens, to calibrating a single camera system, to crafting custom metrology and calibration testbenches tailored for deployment in laboratory or production environments.

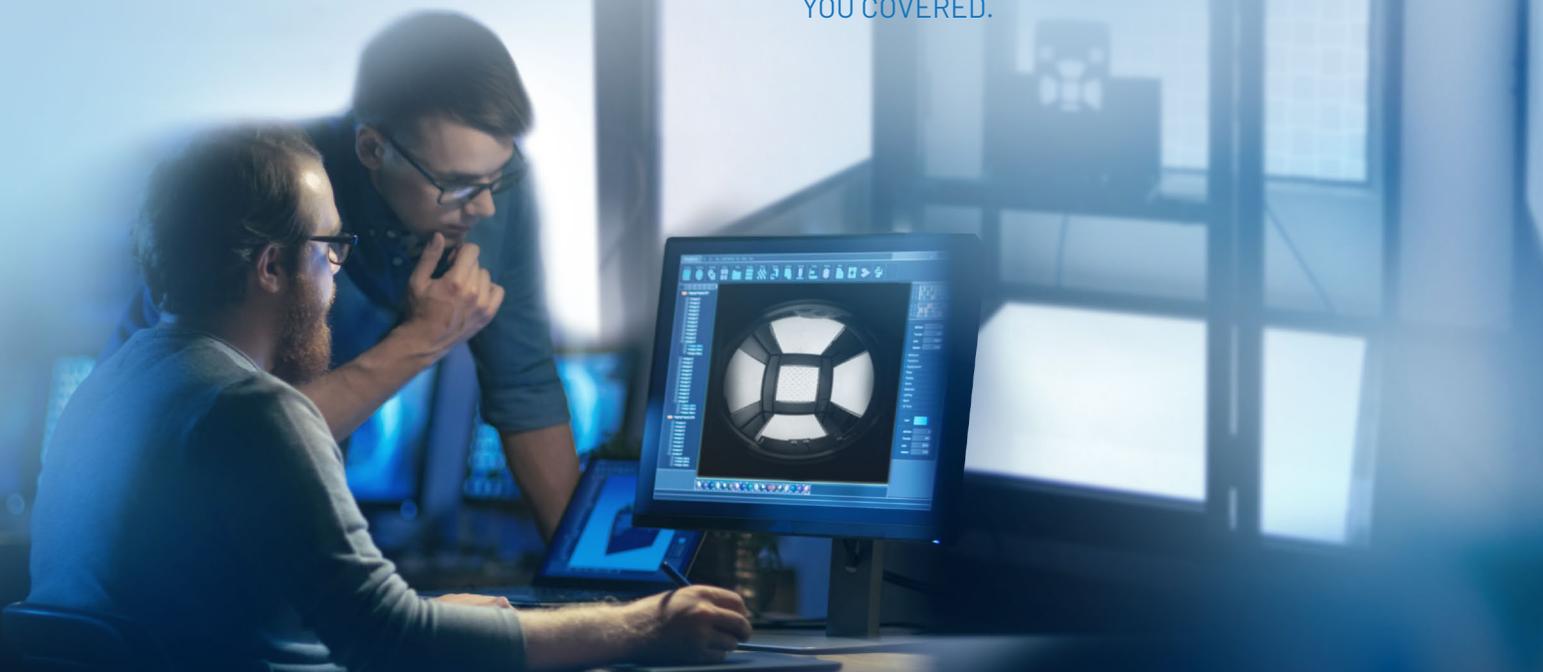
# We Have You Covered

Are you an optical engineer who needs basic metrology on a lens assembly or a deep analysis of each of the sub-lenses forming an assembly? Are you a camera design engineer currently in the proof-of-concept phase requiring metrology on a lens-plus-sensor combination?

Are you a camera system engineer who needs to have a small number of units tested and calibrated? Are you a production engineer tasked with ensuring the quality of camera systems in mass production?

We can perform optical metrology and calibration on your behalf, or we can guide you in establishing metrology and calibration testbenches for use in your own laboratory or in a production environment.

**WHATEVER YOUR NEEDS, WE HAVE YOU COVERED.**



# METROLOGY

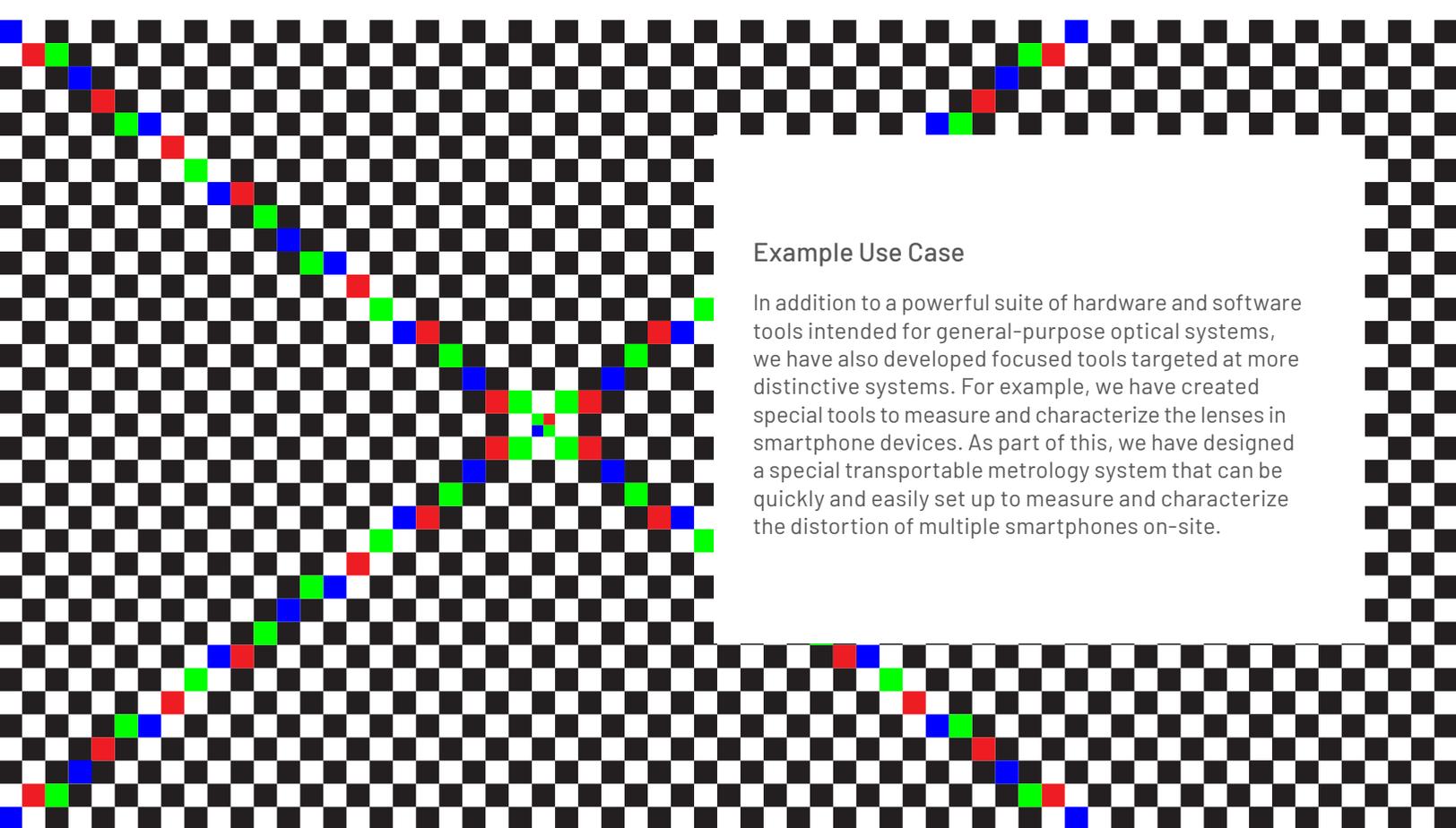
## Basic Metrology Offer

Are you an optical engineer who requires metrology on a full lens assembly? Or are you a camera design engineer requiring metrology on a lens-plus-sensor combination? If so, our Basic Metrology Offer will address all your needs, although it should be noted that this offer is anything but “basic.”

All you need to do is to ship your lens assembly or lens-plus-sensor combo to us and we will use our extensive suite of internally developed hardware and software tools to measure the parameters associated with your specified key performance indicators (KPIs), such as

distortion, modulation transfer function (MTF), spatial frequency response (SFR), lateral color, chief ray angle (CRA) mismatch, relative illumination, thermal behavior, and so forth. Alternatively, if required, we can visit your facility to perform the metrology on-site.

Another service we offer is to define and document a Basic Metrology Testbench to be deployed at your facility that is specifically designed to meet your unique requirements.



### Example Use Case

In addition to a powerful suite of hardware and software tools intended for general-purpose optical systems, we have also developed focused tools targeted at more distinctive systems. For example, we have created special tools to measure and characterize the lenses in smartphone devices. As part of this, we have designed a special transportable metrology system that can be quickly and easily set up to measure and characterize the distortion of multiple smartphones on-site.

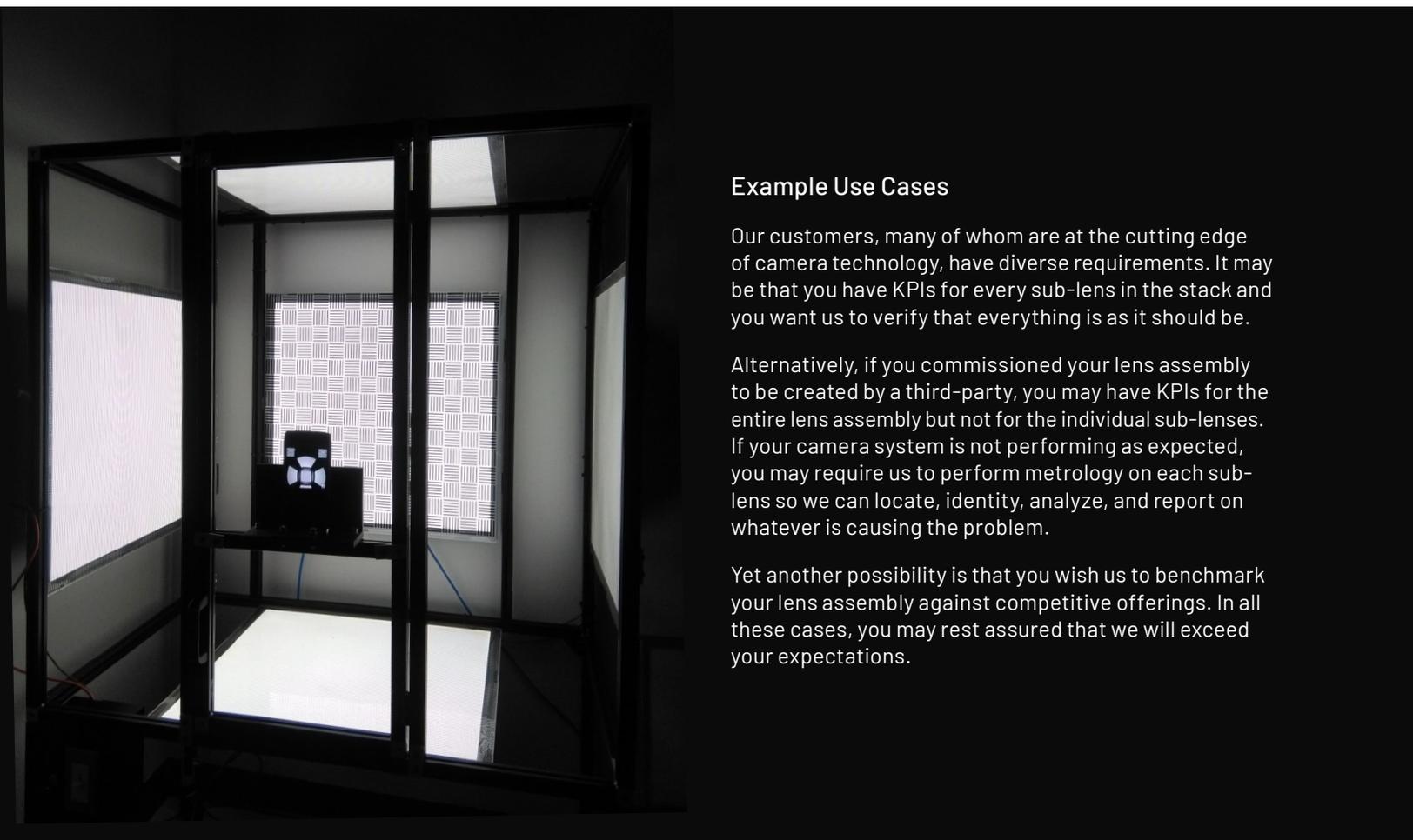
## METROLOGY (CONT'D)

### Advanced Metrology Offer

Today's applications demand ever tighter specifications and tolerances, thereby increasing demands on lens metrology.

In the case of our Advanced Metrology Offer, once you have shipped your lens assembly to us, we will use our extensive suite of internally developed hardware and software tools to measure the parameters associated with your specified KPIs on each of the sub-lenses forming the stack.

Once again, another service we offer is to define and document an Advanced Metrology Testbench to be deployed at your facility that is specifically designed to address your unique requirements.



#### Example Use Cases

Our customers, many of whom are at the cutting edge of camera technology, have diverse requirements. It may be that you have KPIs for every sub-lens in the stack and you want us to verify that everything is as it should be.

Alternatively, if you commissioned your lens assembly to be created by a third-party, you may have KPIs for the entire lens assembly but not for the individual sub-lenses. If your camera system is not performing as expected, you may require us to perform metrology on each sub-lens so we can locate, identify, analyze, and report on whatever is causing the problem.

Yet another possibility is that you wish us to benchmark your lens assembly against competitive offerings. In all these cases, you may rest assured that we will exceed your expectations.

# CALIBRATION

## Calibration Offer

Calibrating traditional camera systems is not easy, especially in the cases of systems that involve multiple cameras to offer capabilities such as stereoscopic machine vision.

The complexity of the task increases when the cameras feature wide-angle, super-wide angle, ultra-wide-angle, and fisheye lenses, and the situation is further exacerbated when the lens assemblies employ freeform technologies that support unlimited degrees of freedom.

We can satisfy all your calibration needs, measuring the distortion curves, Field-of-View (FoV), and any other intrinsic parameters you require to validate information from the lens assembly, sensor module, and camera module providers. We can do this for a single system comprising one, two, or more cameras, or for multiple systems as required.

As for our Metrology Offers, another service we offer is to define and document a Calibration Testbench that's specifically designed to address your unique requirements to be deployed in a laboratory or at a mass production facility.

### Example Use Cases

#### Side-by-Side

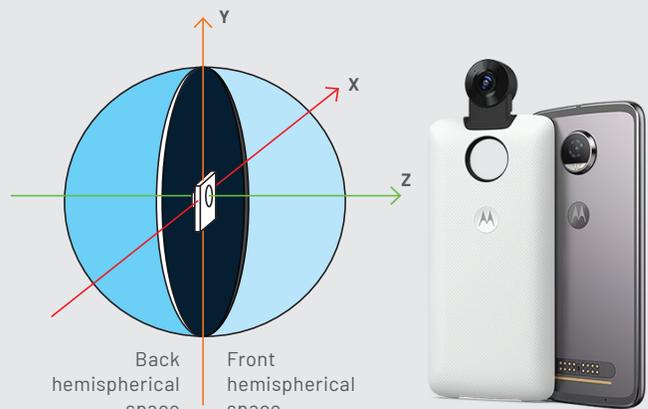
One common calibration use case involves two wide-angle cameras mounted side-by-side to provide stereoscopic machine vision. In addition to measuring and verifying all of the intrinsic parameters and adjusting the individual cameras accordingly, this also includes rotation of, and translation between, the cameras.



PanomorphEYE

#### Back-to-Back

Another increasingly common calibration use case involves the use of two back-to-back cameras equipped with fisheye lenses to provide a  $360^\circ \times 360^\circ$  field of view. In this case, the lenses might be mounted directly back-to-back, or they may be slightly offset, thereby allowing the device to be thinner.



Motorola Moto 360

## Summary of Optical Metrology and Calibration Offers

	BASIC METROLOGY	ADVANCED METROLOGY	CALIBRATION
Single lens assembly	✓	✓	
Multiple lens assemblies	✓	✓	
Single lens + sensor combo	✓	✓	
Single lens + sensor combo	✓	✓	
Metrology performed on-site	✓	✓	
Provide detailed reports	✓	✓	
Define custom basic metrology testbench	✓	✓	
All sub-lenses in single lens assembly		✓	
All sub-lenses in multiple lens assemblies		✓	
Identify problems with existing implementation		✓	
Benchmark against competitive system(s)		✓	
Provide detailed reports		✓	
Define custom advanced metrology testbench		✓	
Single camera system with single camera module			✓
Single camera system with multiple camera modules			✓
Multiple camera systems each with single camera module			✓
Multiple camera systems each with multiple cameras modules			✓
Provide detailed reports			✓
Define custom calibration testbench			✓

# ACCELERATE YOUR PROJECT AND ENSURE A SUCCESSFUL OUTCOME

Wherever you are in your development, from initial planning to early prototyping to pre-production to full production, you really should consider taking advantage of our optical metrology and calibration offers. We would love to work with you on your unique camera vision system projects to satisfy your metrology measurement requirements and address your calibration concerns.

GIVE US A CALL TODAY AND  
LET'S START COLLABORATING TOGETHER!

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